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H. B. ROBINSON STEAM ELECTRIC PLANT, UNIT NO. 2
DOCKET NO. 50-261/LICENSE NO. DPR-23

RESULTS OF INSPECTIONS CONDUCTED IN ACCORDANCE WITH THE FIRST REVISED ORDER ESTABLISHING INTERIM INSPECTION REQUIREMENTS FOR REACTOR PRESSURE VESSEL HEADS AT PRESSURIZED WATER REACTORS

Ladies and Gentlemen:

Inspections in accordance with the NRC's First Revised Order Establishing Interim Inspection Requirements for Reactor Pressure Vessel Heads at Pressurized Water Reactors (EA-03-009) were completed during the most recent refueling outage, designated as RO-22, at H. B. Robinson Steam Electric Plant (HBRSEP), Unit No. 2. Inspections in accordance with Sections IV.C and IV.D of the Order were satisfactorily completed.

The results of these inspections are provided in the attachments to this letter. In accordance with Section IV.E of the Order, these results are being provided within 60 days of the completion of the refueling outage, which ended on May 28, 2004.

If you have any questions concerning this matter, please contact me.

Sincerely,

C. T. Baucom
Supervisor – Licensing/Regulatory Programs

CTB/cac

Progress Energy Carolinas, Inc.
Robinson Nuclear Plant
3581 West Entrance Road
Hartsville, SC 29550

A101

Attachments:

I. Results of Inspections Conducted in Accordance with the First Revised Order Establishing Interim Inspection Requirements for Reactor Pressure Vessel Heads at Pressurized Water Reactors
II. Westinghouse Reactor Vessel Head Penetration Examination Final Report

c: Dr. W. D. Travers, NRC, Region II
Mr. C. P. Patel, NRC
NRC Resident Inspector

H. B. ROBINSON STEAM ELECTRIC PLANT, UNIT NO. 2

RESULTS OF INSPECTIONS CONDUCTED IN ACCORDANCE WITH THE FIRST REVISED ORDER ESTABLISHING INTERIM INSPECTION REQUIREMENTS FOR REACTOR PRESSURE VESSEL HEADS AT PRESSURIZED WATER REACTORS

Background and Introduction

H. B. Robinson Steam Electric Plant (HBRSEP), Unit No. 2, is a 3-loop Westinghouse-designed Nuclear Steam Supply System Pressurized Water Reactor, which is licensed to operate at 2339 Megawatts-thermal. The original operating license was issued July 31, 1970. Inspections in accordance with the NRC's First Revised Order Establishing Interim Inspection Requirements for Reactor Pressure Vessel (RPV) Heads at Pressurized Water Reactors (EA-03-009) were completed during the most recent refueling outage, designated as RO-22. Inspections in accordance with Sections IV.C (bare-metal visual, non-destructive ultrasonic and eddy-current examinations) and IV.D (visual inspection) were completed.

In accordance with Section IV.A of the Order, the effective degradation years (EDY) for the HBRSEP, Unit No. 2, RPV head were calculated. The results of that calculation estimated the EDY for the end of the operating cycle that preceded RO-22 as 21.69. This places HBRSEP, Unit No. 2, in the "High" category of primary water stress corrosion cracking (PWSCC) susceptibility, in accordance with Section IV.B of the Order.

Section IV.C.(1) of the Order requires that plants in the "High" category inspect the RPV head and vessel head penetration (VHP) nozzles using the techniques of paragraphs IV.C.(5)(a) and IV.C.(5)(b) every refueling outage. Additionally, Section IV.D of the Order requires a visual inspection to identify potential boric acid leaks for pressure-retaining components above the RPV head. The inspections and examinations required by the Order were completed during RO-22. The results of these inspections and examinations revealed no active leaks or degradation of the HBRSEP, Unit No. 2, RPV head.

As stated in response to NRC Bulletins 2001-01, 2002-01, and 2002-02, the HBRSEP, Unit No. 2, RPV head was previously examined during RO-20 (April 2001) and RO-21 (October 2002). A bare-metal qualified visual examination of the RPV head and VHP nozzles was conducted during RO-20 in April 2001, which pre-dated the August 2001 issuance of NRC Bulletin 2001-01, "Circumferential Cracking of Reactor Pressure Vessel Head Penetration Nozzles." Subsequent to the issuance of NRC Bulletin 2001-01, and as a result of correspondences, teleconferences, and meetings between HBRSEP, Unit No. 2, and the NRC staff, it was concluded that the April 2001 visual examination provided reasonable assurance of the structural integrity of the VHP nozzles until the next scheduled inspection in the fall of 2002 (Reference TAC No. MB2654).

On December 13, 2002, HBRSEP, Unit No. 2, submitted the results of RPV head and VHP nozzle inspections completed in November 2002 as part of RO-21. That submittal and the associated RO-21 inspections were in accordance with the HBRSEP, Unit No. 2, responses to NRC Bulletin 2001-01, and NRC Bulletin 2002-02, "Reactor Pressure Vessel Head and Vessel Head Penetration Nozzle Inspection Programs." Inspections performed during RO-21 included a bare-metal qualified visual examination of the RPV head surface, which was a visual examination for evidence of leakage 360° around each nozzle-head intersection and non-destructive examination (NDE) of the VHP nozzles. As described within the December 13, 2002, submittal, the scope of the NDE for these examinations included:

- Eddy current examinations of the 69 J-groove welds and penetration tube outer diameter (OD) surfaces,
- Eddy current and ultrasonic examinations of the seventeen open penetration tubes from the penetration tube inner diameter (ID) surfaces, and
- Eddy current examinations of 45 penetration tubes with thermal sleeves and seven penetration tubes with part length drive shafts from the penetration tube ID surfaces.

The RO-21 bare-metal qualified visual examination of the RPV head and VHP nozzles did not identify evidence of VHP nozzle leakage or PWSCC-induced cracking. Additionally, the NDE of the RPV head penetrations found no evidence of service-related degradation. One recordable indication was identified that did not require repair. An engineering analysis of that indication has been completed, and the crack growth model associated with that analysis shows the applied stress intensity factor for the indication to be below the threshold for crack propagation. The engineering analysis further concluded that the indication is most likely a scratch or other surface anomaly resulting from the manufacturing process, and there is no concern for this indication during future service (Reference TAC No. MB5916).

The results of the examinations and inspections conducted during the past three refueling outages (RO-20, 21, and 22) provide adequate assurance of the integrity of the HBRSEP, Unit No. 2, RPV head and VHP nozzles. Even in light of these results, Carolina Power and Light Company, now doing business as Progress Energy Carolinas, Inc., plans to replace the RPV head during the next refueling outage, which is scheduled for the fall of 2005. This replacement was deemed necessary due to the burden associated with the required examinations for a plant in the "High" susceptibility category.

Results of RO-22 Inspections and Examinations

The RO-22 inspections and examinations were conducted in accordance with the Order requirements, which are summarized as follows:

- Order Section IV.C.(5)(a) requires bare-metal visual examination of the RPV head surface.
- Order Section IV.C.(5)(b) requires non-visual NDE of the VHP nozzles.

- Order Section IV.D requires visual inspection for boric acid leaks from pressure-retaining components above the RPV head.

These inspections and examinations were conducted during RO-22 in April and May of 2004.

The bare-metal visual examination and visual inspection of the components above the RPV head found no evidence of active leakage and no significant degradation. A boric acid film was found on two penetrations (Penetration Nos. 30 and 50) above the RPV head. This boric acid residue was determined to be attributable to RPV head penetration canopy seal weld leaks that had occurred during a previous operating cycle, and repairs were completed during the previous refueling outage (RO-21) to correct these leaks. No boric acid residue was observed on the RPV head insulation at these locations.

The non-visual NDE of the VHP nozzles was performed by Westinghouse Electric Company – Nuclear Services. These examinations were completed using ultrasonic examination, eddy current examination, and combinations of these two techniques on individual penetrations. Attachment II provides a detailed report of these RO-22 examinations. This Westinghouse report concludes that the results from the time-of-flight diffraction (TOFD) ultrasonic and eddy current examinations of the 69 RPV head penetrations identified no indications that are characteristic of PWSCC.

Conclusion

Inspections and examinations in accordance with the First Revised Order Establishing Interim Inspection Requirements for Reactor Pressure Vessel Heads at Pressurized Water Reactors (EA-03-009) were completed during the most recent refueling outage (RO-22) at HBRSEP, Unit No. 2. These examinations found no indications of PWSCC, active leakage, or material wastage of the RPV head and VHP nozzles.

U.S. Nuclear Regulatory Commission
Attachment II to Serial: RNP-RA/04-0086
41 Pages (including cover page)

H. B. ROBINSON STEAM ELECTRIC PLANT, UNIT NO. 2

WESTINGHOUSE REACTOR VESSEL HEAD PENETRATION EXAMINATION FINAL REPORT

H.B. Robinson Unit 2–RO22 Reactor Vessel Head Penetration Examination

May 2004

Final Report

1302612-04, Rev. 0

May 27, 2004

Westinghouse Electric Company
Nuclear Services
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USA

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1.0 INTRODUCTION

During the H.B. Robinson Unit 2 RO22 outage in the Spring of 2004, Westinghouse performed nondestructive examinations (NDE) of the sixty-nine control rod drive mechanism (CRDM) penetration tubes in the reactor vessel head.

The purpose of the examination program was to identify evidence of primary water stress corrosion cracking (PWSCC) that might be present on the outside diameter (OD) and inside diameter (ID) surfaces of the head penetration tubes and to assess whether leakage might have might have occurred into annulus at the tube-to-head interface. Examinations were performed using procedures and techniques demonstrated through the EPRI/MRP protocol [1], and/or Westinghouse internal demonstration programs, and applied consistent with the requirements of the February 20, 2004, First Revision to USNRC Order EA-03-009, "Establishing Interim Inspection Requirements for Reactor Vessel Heads at Pressurized Water Reactors".

The Robinson reactor vessel head is a Westinghouse design and manufactured by Combustion Engineering (CE). The head contains sixty-nine alloy 600 penetration tubes that are shrunk fit into the reactor vessel head and attached with alloy 182/82 partial penetration J-groove welds.

All CRDM penetration tubes in the H.B. Robinson Unit 2 reactor vessel head were manufactured from heats of material supplied by Huntington Alloys. To date, penetrations manufactured from Huntington material have exhibited better resistance to PWSCC than those manufactured from material supplied by B&W tubular products.

Locations of heats of Huntington material in the H.B. Robinson Unit 2 head are identified in Table 1-1, below.

Table 1-1: Penetration Location and Associated Heat Number

Penetration	Heat No.	Yield (psi)	Ultimate (psi)
1	NX1474	53	94
2	NX1474	53	94
3	NX0139	36	93
4	NX1474	53	94
5	NX1474	53	94
6	NX1872	57.5	91
7	NX1872	57.5	91
8	NX1872	57.5	91
9	NX1872	57.5	91
10	NX1872	57.5	91
11	NX1872	57.5	91
12	NX1872	57.5	91
13	NX1872	57.5	91
14	NX1872	57.5	91
15	NX1872	57.5	91
16	NX0399	41.5	94
17	NX0399	41.5	94

Penetration	Heat No.	Yield (psi)	Ultimate (psi)
18	NX1872	57.5	91
19	NX0399	41.5	94
20	NX1872	57.5	91
21	NX1872	57.5	91
22	NX0399	41.5	94
23	NX0399	41.5	94
24	NX0399	41.5	94
25	NX0399	41.5	94
26	NX0399	41.5	94
27	NX0399	41.5	94
28	NX0139	36	93
29	NX0399	41.5	94
30	NX0399	41.5	94
31	NX0399	41.5	94
32	NX5981	35.5	91.5
33	NX0399	41.5	94
34	NX0399	41.5	94

Penetration	Heat No.	Yield (psi)	Ultimate (psi)
35	NX0399	41.5	94
36	NX0399	41.5	94
37	NX0399	41.5	94
38	NX1474	53	94
39	NX5983	36	88
40	NX1474	53	94
41	NX1527	47.5	95.5
42	NX1527	47.5	95.5
43	NX1527	47.5	95.5
44	NX1527	47.5	95.5
45	NX1527	47.5	95.5
46	NX0139	36	93
47	NX1527	47.5	95.5
48	NX1527	47.5	95.5
49	NX1527	47.5	95.5
50	NX1474	53	94
51	NX1474	53	94
52	NX1527	47.5	95.5

Penetration	Heat No.	Yield (psi)	Ultimate (psi)
53	NX4277	36.5	91
54	NX1527	47.5	95.5
55	NX1527	47.5	95.5
56	NX1527	47.5	95.5
57	NX1527	47.5	95.5
58	NX1474	53	94
59	NX1474	53	94
60	NX1474	53	94
61	NX1474	53	94
62	NX1474	53	94
63	NX1474	53	94
64	NX1474	53	94
65	NX1474	53	94
66	NX1474	53	94
67	NX0400	49.5	92.5
68	NX1474	53	94
69	NX0400	49.5	92.5

There are a variety of configurations for the sixty-nine penetration tubes, each configuration requiring special consideration for examination. The penetration tubes measure 4.0" on the OD and have an ID dimension of 2.75". The wall thickness is 0.625". The penetration tube configurations are as follows:

- 17 open penetration tubes
- 45 penetration tubes with thermal sleeves installed
- 7 penetration tubes with part length drive shafts

The H.B. Robinson Unit 2 reactor vessel head is in the "high susceptibility" category. For a reactor vessel head in this category, Section IV.C (5) of the first Revision to USNRC Order EA-03-009 [2] specifies:

a) *Bare metal visual examination of 100% of the RPV head surface (including 360^{o} around each RPV head penetration nozzle), and*

b) *For each penetration, perform a nonvisual NDE in accordance with either i, ii or iii:*

   i. *Ultrasonic testing of each RPV head penetration nozzle volume (i.e., nozzle base material) from two (2) inches above the highest point of the root of the J-groove weld to 2 inches below the lowest point at the toe of the J-groove weld on a horizontal plane perpendicular to the nozzle axis; OR from 2 inches above the highest point of the root of the J-groove weld to 1 inch below the lowest point at the toe of the J-groove weld and including all RPV head penetration nozzle surfaces below the J-groove weld that have an operating stress level of 20 ksi tension and greater. In addition, an assessment shall be made to determine if leakage has occurred into the annulus between the RPV head penetration nozzle and the RPV head low alloy steel.*

   ii. *Eddy current or dye penetrant testing of the entire wetted surface of the J-groove weld and the wetted surface of the RPV head penetration nozzle base material from at least 2 inches above the highest point of the root of the J-groove weld to 2 inches below the lowest point at the toe of the J-groove weld on a horizontal plane perpendicular to the nozzle axis; OR from 2 inches above the highest point of the root of the J-groove weld to 1 inch below the lowest point at the toe of the J-groove weld and including all RPV head penetration nozzle surfaces below the J-groove weld that have an operating stress level of 20 ksi tension and greater.*

   iii. *A combination of (i) and (ii) to cover equivalent volumes, surfaces and leak paths of the RPV head penetration nozzle base material and J-groove welds described in (i) and (ii).*

...shall be performed at least once over the course of every refueling outage.

The examination program selected for H.B. Robinson Unit 2 included ultrasonic examinations of the 69 CRDM penetration nozzles with leakage assessment in accordance with Section IV.C (5) (b) (i) of the Revised NRC Order.

Stress distribution curves were developed in advance of the examination which demonstrated that hoop stresses on the OD surfaces of the tubes are less than 20 ksi within 1.0" below the lowest point of the toe of the J-groove weld [3], thus the examination coverage required for all penetration locations was from 2 inches above the highest point of the root of the J-groove weld to 1 inch below the lowest point at the toe of the J-groove weld. The stress distribution curves are attached as Appendix A.

Contingency plans were in place to address the possibility that geometric conditions at certain penetration locations, including asymmetry of the penetration tubes due to weld distortion and "short tubes" below the J-groove welds, might result in an inability achieve the examination coverage specified in the Revised NRC Order. Contingencies included equipment and procedures necessary to: 1) perform wetted surface examinations in accordance with Section IV.C (5) (b) (ii) of the Revised Order using eddy current blade probes, which are thinner that the Trinity blade probes, on the tube ID surfaces supplemented by eddy current examinations of the associated J-groove welds and tube OD surfaces with the Grooveman end effector, and/or 2) use a combination of ultrasonic and eddy current techniques to satisfy the Revised Order in accordance with Section IV.C (5) (b) (iii). It was necessary to implement contingency inspections at twenty-five penetration locations. At seventeen locations tube asymmetry would not allow the Trinity probes to pass freely in the annulus between the penetration tubes and thermal sleeves, thus wetted surface eddy current examinations were performed. At eight locations, it was not possible to achieve 1.0" of examination coverage below the toe of the J-groove welds on the tube OD surfaces with TOFD-UT and supplementary eddy current examinations were performed.

The following Westinghouse field service procedures and associated field change notices (FCNs) were approved for use at H.B. Robinson Unit 2.

- WDI-ET-002, Rev. 4 and FCN 01 – "Eddy Current Inspection of J-Groove Welds in Vessel Head Penetrations"

- WDI-ET-003, Rev. 6 and FCNs 01 and 02 – "IntraSpect Eddy Current Imaging Procedure for Inspection of Reactor Vessel Head Penetrations"

- WDI-ET-004, Rev. 5 and FCNs 01 and 02 – "IntraSpect Eddy Current Analysis Guidelines Inspection of Reactor Vessel Head Penetrations"

- WDI-ET-008, Rev. 3 and FCN-01 – "IntraSpect Eddy Current Imaging Procedure for Inspection of Reactor Vessel Head Penetrations With Gap Scanner"

- WDI-UT-010, Rev 7 and FCNs 01, 02 and 03 - "IntraSpect Ultrasonic Procedure for Inspection of Reactor Vessel Head Penetrations, Time of Flight Ultrasonic & Longitudinal Wave"

- WDI-UT-013, Rev. 5 and FCNs 01 and 02 – "CRDM/ICI UT Analysis Guidelines"
- WCAL-002, Rev. 3 – "Pulser/Receiver Linearity Procedure"

The vessel head penetrations were dispositioned based on an assessment of results from the nondestructive examinations presented herein and results from visual examinations performed from the top of the reactor vessel head.

2.0 SCOPE OF WORK

The reactor vessel head penetration nondestructive examination scope at H.B. Robinson Unit 2 included all sixty-nine CRDM penetration tubes.

The examination methodology selected for each penetration was dependent upon the penetration tube configuration and penetration-specific geometric conditions. Refer to Appendix B for penetration-specific details.

1. Seventeen penetration tubes without thermal sleeves were examined from the ID using the Westinghouse 7010 Open Housing Scanner (OHS).

2. Thirty-five penetrations, twenty-eight with thermal sleeves and seven part length locations, were examined from the ID using the Westinghouse Gapscanner and Trinity blade probes.

3. Due to the combination of probe design and penetration geometry, it was not possible to achieve 1.0" of examination coverage below the lowest portion of the J-groove welds on the OD surfaces of eight of the thirty-five locations identified in 2, above, using time-of-flight diffraction ultrasonic testing (TOFD UT) techniques with the Trinity blade probes. For these eight locations, TOFD UT coverage below the weld varied from 0.6" to 0.96". The penetration tube OD surfaces at these locations were examined using eddy current techniques with the Grooveman end effector to achieve at least 1.0" of examination coverage below the lowest elevation of the J-groove weld.

4. The examination program for seventeen penetration tubes containing thermal sleeves was changed from the Trinity blade probes to the eddy current probes, which are slightly thinner, because the sizes of the gaps between the OD of the thermal sleeves and the ID of the penetration tubes varied around the circumference and the Trinity probes would not pass freely in the annulus. This asymmetric condition appears to be a result of distortion of the penetration tubes due to welding.

   These seventeen penetration tubes were inspected from the ID using the Westinghouse Gapscanner and dual-pancake eddy current blade probes. The J-groove welds and penetration tube OD surfaces at these locations were also examined using eddy current techniques with the Grooveman end effector.

The delivery system used for the CRDM examinations at H.B. Robinson Unit 2 was the Westinghouse DERI 700 manipulator.

The DERI 700 is a multi-purpose robot that can access all head penetrations and provides a common platform for all CRDM examination end effectors. The manipulator consists of a central leg, mounted on a carriage, which in turn is mounted onto a guide rail. The manipulator arm, with elbow and removable wrist, is mounted onto the carriage, which travels vertically along the manipulator leg.

The DERI 700 was used to deliver 1) the Westinghouse 7010 Open Housing Scanner for ultrasonic and supplementary eddy current examinations of open penetration locations, 2) the Westinghouse Gapscanner end effector for Trinity probe examinations of penetration locations containing thermal sleeves and part length locations, 3) the Westinghouse Gapscanner for eddy current blade probe examinations where access was inadequate for the Trinity probes, and 4) the Grooveman end effector when required for eddy current examinations of the J-groove welds and/or penetration tube OD surfaces.

The Westinghouse 7010 Open Housing Scanner delivers an examination wand containing ultrasonic and eddy current probes to the ID surface of open reactor vessel head penetrations. The scanning motion is in a vertical direction moving from a specified height above the weld, in this case at least 2.0", to the bottom of each penetration. The probe is indexed in the circumferential direction. With the open housing scanner, multiple examination probes are delivered simultaneously. These include time-of-flight diffraction ultrasonic probes oriented in the axial and circumferential directions, straight beam ultrasonic probes to identify variations in the penetration tube-to-reactor vessel head shrink fit area that might indicate a leak path in the annulus between the tube and the head, and supplementary eddy current probes for identification of circumferential and axial degradation on the ID surfaces of the penetration tubes

The Gapscanner end effector delivers either Trinity blade probes or eddy current blade probes into the annulus between the ID surface of the head penetration tube and the OD surface of the thermal sleeve or part length drive shaft. The typical annulus size is 0.125". The Trinity probes include a crosswound eddy current coil, a TOFD UT transducer pair and a 0° ultrasonic transducer. The eddy current blade probes use a dual pancake coil arrangement. Both probe designs feature a flexible metal "blade" on which ultrasonic and/or eddy current probes are mounted in a spring configuration that enables the probes to ride on the ID surface of the penetration tubes. The scanning motion is in a vertical direction moving from a specified height above the weld, in this case at least 2.0", to the bottom of each penetration. The probes are indexed in the circumferential direction.

The Grooveman manipulator is designed to deliver crosswound eddy current probes for examination of the surface of the J-groove weld and the penetration nozzle OD surfaces. The eddy current probe holders are designed to conform to the geometry of the J-groove welds and penetration OD surfaces and allow the probes to follow the contour of the assembly. Continuous positional and video feedback is provided to the operator to assist in achieving coverage of the weld and the penetration tube. Scanning of the penetration tube OD surface is conducted in a vertical direction and the probes are indexed in the circumferential direction. For scanning of the J-groove welds, scanning is conducted in the circumferential direction, along the weld, and the index is in a direction perpendicular to the weld.

2.1 7010 Open Housing Scanner Ultrasonic and Eddy Current Examinations

7010 Open Housing Scanner examinations were conducted on seventeen reactor vessel head penetrations without thermal sleeves.

Examinations of these vessel head penetrations included:

1. TOFD ultrasonic techniques demonstrated capable of detecting axial and circumferential degradation on the penetration tube OD and ID surfaces with PCS24 probes in accordance with WDI-UT-010, Rev. 7 and FCNs 01, 02 and 03 – "IntraSpect Ultrasonic Procedure for Inspection of Reactor Vessel Head Penetrations, Time of Flight Ultrasonic Longitudinal Wave" & Shear Wave",

2. straight beam ultrasonic techniques to identify possible leak paths in the shrink fit region between the head penetrations and the reactor vessel head, also in accordance with WDI-UT-010, Rev. 7 and associated FCNs, and

3. supplementary eddy current examinations demonstrated capable of detecting axial and circumferential degradation on the penetration tube ID surfaces in accordance with and WDI-ET-003, Rev. 6 and FCNs 01 and 02 - "IntraSpect Eddy Current Imaging Procedure for Inspection of Reactor Vessel Head Penetrations".

2.2 Gapscanner Penetration Tube ID Surface Trinity Probe Examinations

Examinations were performed with the Gapscanner end effector and Trinity probes on thirty-five penetration tubes, twenty-eight with thermal sleeves and seven part length locations, from the penetration ID surfaces. These thirty-five penetration tubes were inspected from the ID using Trinity blade probes.

Examinations of these vessel head penetrations included:

1. TOFD ultrasonic techniques demonstrated capable of detecting axial and circumferential degradation on the penetration tube OD and ID surfaces with PCS24 probes in accordance with WDI-UT-010, Rev. 7 and FCNs 01, 02 and 03 – "IntraSpect Ultrasonic Procedure for Inspection of Reactor Vessel Head Penetrations, Time of Flight Ultrasonic Longitudinal Wave" & Shear Wave",

2. straight beam ultrasonic techniques to identify possible leak paths in the shrink fit region between the head penetrations and the reactor vessel head, also in accordance with WDI-UT-010, Rev. 7 and associated FCNs, and

3. supplementary eddy current examinations demonstrated capable of detecting axial and circumferential degradation on the penetration tube ID surfaces in accordance with and WDI-ET-003, Rev. 6 and FCNs 01 and 02 - "IntraSpect Eddy Current Imaging Procedure for Inspection of Reactor Vessel Head Penetrations".

2.3 Gapscanner Penetration Tube ID Surface Eddy Current Examinations

Gapscanner eddy current examinations were conducted on the remaining seventeen reactor vessel head penetration where the sizes of the gaps between the OD of the thermal sleeves and the ID of the penetration tubes varied around the circumference and the Trinity probes would not pass freely in the annulus. Eddy current blade probes with dual pancake eddy current coils were used to examine the tube ID surfaces. These examinations were applied to identify the presence of primary water stress corrosion cracking (PWSCC) on the inside diameter surfaces of the penetration tubes. Examinations were conducted in accordance with WDI-ET-008, Rev. 3 and FCN 01 – "IntraSpect Eddy Current Imaging Procedure for Inspection of Reactor Vessel Head Penetrations With Gap Scanner".

The J-groove welds and penetration tube OD surfaces at these locations were also examined using eddy current techniques with the Grooveman end effector.

2.4 J-Weld and Penetration Tube OD Surface Eddy Current Examinations

Eddy current examinations were performed on the J-groove welds and outside diameter surfaces of seventeen reactor vessel head penetration tubes to supplement the Gapscanner ID eddy current examinations. The Grooveman end effector delivers crosswound eddy current coils to identify the presence of primary water stress corrosion cracking on the outside diameter surfaces of penetration tubes and on the surfaces of the J-groove welds attaching the penetrations to the reactor vessel head. Examinations were conducted in accordance with WDI-ET-002, Rev. 4 and FCN 01 – "IntraSpect Eddy Current Inspection of J-Groove Welds in Vessel Head Penetrations".

In addition, Grooveman eddy current examinations were conducted on the outside diameter surfaces of eight reactor vessel head penetration tubes where it was not possible to achieve 1.0" of examination coverage on the tube OD surface using TOFD techniques with the Trinity Probes.

3.0 EXAMINATION RESULTS

3.1 7010 Open Housing Scanner Ultrasonic and Eddy Current Examinations

Table 3-1 provides a summary of results from the 7010 Open Housing Scanner reactor vessel head penetration nondestructive examinations performed at H.B. Robinson Unit 2 during the RO22 refueling outage.

Table 3-1: Open Housing Scanner Examination Results

Penetration #	Axial TOFD Channel 1	Circ TOFD Channel 2	2.25 Mhz 0°	5.0 Mhz 0°	Supplementary Tube ID ECT
2	NDD	NDD	NDD	NDD	CC/NDD
3	NDD	NDD	NDD	NDD	NDD
4	NDD	NDD	NDD	NDD	CC/NDD
5	NDD	NDD	NDD	NDD	NDD
11	NDD	NDD	NDD	NDD	NDD
46	NDD	NDD	NDD	NDD	NDD
47	NDD	NDD	NDD	NDD	CC/NDD
48	NDD	NDD	NDD	NDD	NDD
49	NDD	NDD	NDD	NDD	CC/NDD
50	NDD	NDD	NDD	NDD	CC/NDD
51	NDD	NDD	NDD	NDD	CC/NDD
52	NDD	NDD	NDD	NDD	CC/NDD
53	NDD	NDD	NDD	NDD	CC/NDD
54	NDD	NDD	NDD	NDD	CC/NDD
55	NDD	NDD	NDD	NDD	CC/NDD
56	NDD	NDD	NDD	NDD	NDD
57	NDD	NDD	NDD	NDD	NDD

Legend

NDD: No Detectable Degradation
CC : Craze Cracking

No detectable degradation characteristic of PWSCC was reported in any of the penetration tubes examined with the 7010 Open Housing Scanner. There was no evidence of leakage in the annulus between the penetration nozzles and the reactor vessel head. Supplementary eddy current examinations showed evidence of craze cracking on the ID surfaces of ten penetration tubes. All were confirmed by historical data from the Fall 2002 examination and there was no change in size. None were visible in the ultrasonic data; i.e., there was no evidence of craze cracking in the TOFD UT results.

3.2 Gapscanner Penetration Tube ID Surface Trinity Probe Examinations

Table 3-2 provides a summary of results from Gapscanner examinations performed with Trinity Probes performed at H.B. Robinson Unit 2 during the RO22 May 2004 refueling outage. Penetrations identified as shaded in the table were examined using other techniques; i.e., either 1) the Open Housing Scanner or 2) the Gapscanner using eddy current probes supplemented with eddy current examinations of the J-groove weld and penetration tube OD surfaces with the Grooveman end effector.

Table 3-2: Trinity Probe Examination Results

Penetration #	PCS24 TOFD	0° Leak Path	Supplementary Eddy Current Tube ID
1	NDD	NDD	NDD
2	----	----	----
3	----	----	----
4	----	----	----
5	----	----	----
6	NDD	NDD	CC/NDD
7	NDD	NDD	NDD
8	NDD	NDD	CC/NDD
9	NDD	NDD	CC/NDD
10	NDD	NDD	NDD
11	----	----	----
12	NDD	NDD	NDD
13	NDD	NDD	CC/NDD
14	NDD	NDD	CC/NDD
15	----	----	----
16	NDD	NDD	NDD
17	NDD	NDD	NDD
18	NDD	NDD	NDD
19	NDD	NDD	NDD
20	NDD	NDD	NDD
21	NDD	NDD	NDD
22	NDD	NDD	NDD
23	----	----	----
24	----	----	----
25	NDD	NDD	CC/NDD
26	----	----	----
27	----	----	----
28	NDD	NDD	NDD
29	NDD	NDD	NDD
30	----	----	----
31	NDD	NDD	NDD
32	----	----	----
33	----	----	----
34	NDD	NDD	CC/NDD
35	----	----	----
36	NDD	NDD	NDD
37	----	----	----
38	NDD	NDD	NDD
39	----	----	----
40	----	----	----

Penetration #	PCS24 TOFD	0° Leak Path	Supplementary Eddy Current Tube ID
41	NDD	NDD	NDD
42	NDD	NDD	NDD
43	NDD	NDD	CC/NDD
44	NDD	NDD	CC/NDD
45	NDD	NDD	CC/NDD
46	----	----	----
47	----	----	----
48	----	----	----
49	----	----	----
50	----	----	----
51	----	----	----
52	----	----	----
53	----	----	----
54	----	----	----
55	----	----	----
56	----	----	----
57	----	----	----
58	NDD	NDD	CC/NDD
59	NDD	NDD	CC/NDD
60	NDD	NDD	NDD
61	NDD	NDD	CC/NDD
62	NDD	NDD	NDD
63	----	----	----
64	----	----	----
65	----	----	----
66	NDD	NDD	NDD
67	NDD	NDD	CC/NDD
68	----	----	----
69	----	----	----

No detectable degradation characteristic of PWSCC was reported in any of the penetration tubes examined with the Trinity Probes. There was no evidence of leakage in the annulus between the penetration nozzles and the reactor vessel head. Supplementary eddy current examinations showed evidence of craze cracking on the ID surfaces of fourteen penetration tubes. All were confirmed by historical data from the Fall 2002 examination and there was no increase in size. None were visible in the ultrasonic data; i.e., there was no evidence of craze cracking in the TOFD UT results.

3.3 Gapscanner Penetration Tube ID Surface Eddy Current Examinations

Table 3-3 provides a summary of results from Gapscanner examinations performed with eddy current performed at H.B. Robinson Unit 2 during the RO22 May 2004 refueling outage.

Table 3-3: Gapscanner ID Eddy Current Results

Penetration #	Eddy Current
15	NDD
23	NDD
24	NDD
26	NDD
27	NDD
30	NDD
32	NDD
33	NDD
35	NDD
37	NDD
39	NDD
40	NDD
63	NDD
64	NDD
65	NDD
68	NDD
69	NDD

No detectable degradation characteristic of PWSCC was reported in any of the penetration tubes examined with the eddy current blade probes and Gapscanner.

3.4 J-Weld and Penetration Tube OD Surface Eddy Current Examinations

The following table provides a summary of results for all J-groove weld and penetration tube OD surface eddy current examinations performed on the Robinson 2 reactor vessel head during the RO22 outage.

Examinations of penetrations #15, 23, 24, 26, 27, 30, 32, 33, 35, 37, 39, 40, 63, 64, 65, 68 and 69 were specified when it was discovered that the sizes of the gaps between the OD of the thermal sleeves and the ID of these penetration tubes varied around the circumference and the Trinity probes would not pass freely in the annulus. These examinations covered both the J-groove welds and the penetration tube OD surfaces.

Examinations of penetrations #38, 43, 44, 60, 61, 62, 66 and 67 were specified because the TOFD UT examinations from the inside diameter surfaces were not able to achieve 1.0" of examination coverage below the lowest portion of the J-groove weld on the OD surface due to the combination of probe design and penetration geometry. TOFD UT coverage ranged from 0.6" to 0.96". For these penetrations, the examinations covered only the tube OD surfaces from the lowest elevation of the J-groove weld to at least 1.0" below that elevation.

Table 3-4: Grooveman Eddy Current Results

Penetration #	J-Groove Weld Scan	Tube Scan
15	NDD	NDD
23	NDD	NDD
24	NDD	NDD
26	NDD	NDD
27	NDD	NDD
30	NDD	NDD
32	NDD	NDD
33	NDD	NDD
35	NDD	NDD
37	NDD	NDD
38	----	NDD
39	NDD	NDD
40	NDD	NDD
43	----	NDD
44	----	NDD
60	----	NDD
61	----	NDD
62	----	NDD
63	NDD	NDD
64	NDD	NDD
65	NDD	NDD
66	----	NDD
67	----	NDD
68	NDD	NDD
69	NDD	NDD

No detectable degradation characteristic of PWSCC was reported in any of the J-groove welds or penetration tubes examined with eddy current blade probes and the Grooveman end effector.

4.0 EXAMINATION COVERAGE

4.1 Penetration Tube Configuration and Examination Summary

The typical configuration of a sleeved H.B. Robinson Unit 2 CRDM penetration tube is illustrated in Figure 4-1. This figure represents the tube-to-head geometry at the penetration 0° azimuth, or "downhill" side of the tube. The tubes are 0.625" thick and have a 0.188" radius machined at the bottom. The distance from the bottom of the tube to the elevation where the fillet of the J-groove weld intersects the tube (identified as the sum of distances "A" and "0.45" in Figure 1) varies based on location of the penetration in the head. These distances are typically longer for penetrations at "inboard" locations and become progressively shorter for penetrations located further away from the center of the head. The examination methodology selected for each penetration in order to meet the revised NRC Order was dependent upon the penetration tube configuration and penetration-specific geometric conditions, as described in Sections 4.2, 4.3 and 4.4. A penetration-specific summary is provided in Appendix B.

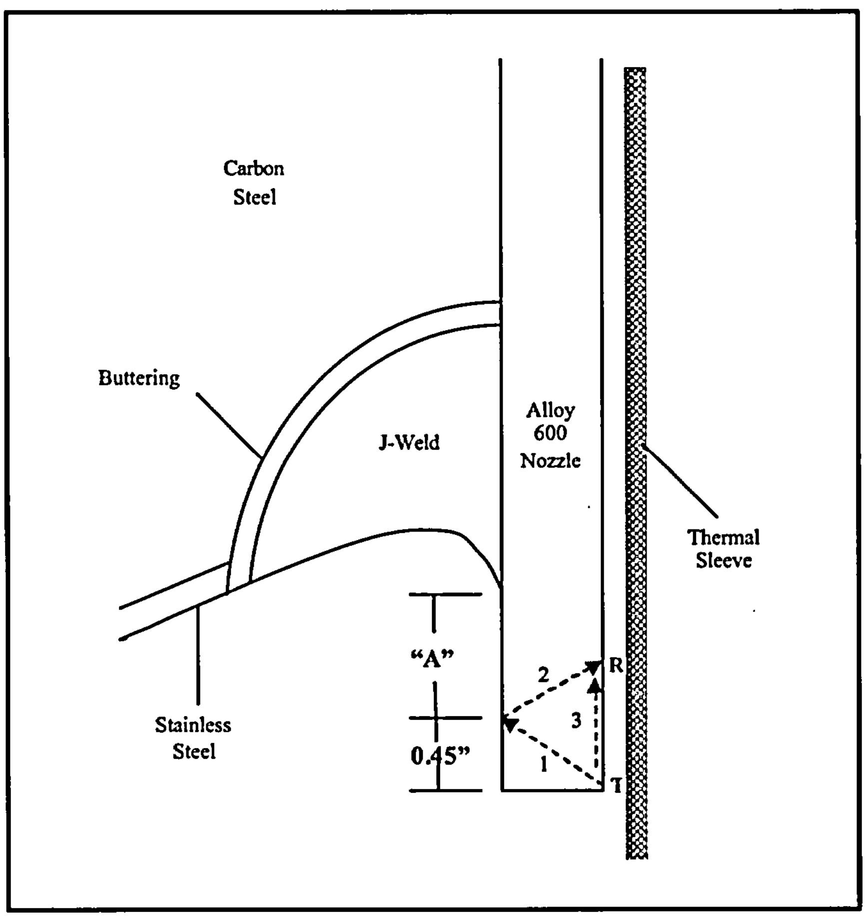


Figure 4-1: Illustration of Axially Oriented TOFD Examination Coverage on H.B. Robinson Penetration Geometry at 0° (Downhill Side)

4.2 Ultrasonic Testing Coverage in Accordance With Section IV.C (5) (b) (i) of the Revised NRC Order

The ultrasonic method demonstrated through the EPRI/MRP Protocol for detection of circumferential and axial degradation on the OD and ID surfaces of CRDM penetration tubes is the axially-oriented time-of-flight diffraction (TOFD) technique. The TOFD technique is a "pitch/catch" ultrasonic method, where the signal is transmitted into the tube at an angle by a transmitter (T) and reflects off of the backside of the tube to a receiver (R), as shown in path 1-2 in Figure 4-1. A lateral wave also travels on the tube ID surface between the transmitter and receiver as shown in path 3. The two transducers are mounted on a probe head with a probe center spacing of 0.925". ID TOFD coverage is provided by the lateral wave to the bottom of the tube on the ID surface. OD TOFD coverage becomes effective at an elevation of ~0.45" from the bottom of the tube.

For ID examinations of the fifty-two penetration tubes performed with the Open Housing Scanner and Trinity blade probes, TOFD PCS24 and supplementary eddy current examination coverage extended from the bottom of each tube to at least 2.0" above the uppermost elevation of the welds. The extent of coverage was verified for each penetration by confirming that: 1) tube entry signals were evident in the eddy current and ultrasonic data, and 2) scan coverage elevations were in excess of 2.0" above the uppermost elevation of each weld. In all cases, ID coverage included at least 1.0" below the lowest elevation of the J-groove welds.

For OD examinations of fifty-two penetration tubes performed with the Open Housing Scanner and Trinity blade probes, the TOFD PCS24 transducer coverage extended from 0.45" above the bottom of each tube to elevations at least 2.0" above the welds. The extent of coverage was verified for each examination of each penetration by confirmation that 1) TOFD tube entry signals were evident ultrasonic data and 2) scan coverage elevations were in excess of 2.0" above the uppermost elevation of each weld. TOFD UT coverage obtained for forty-four of the fifty-two tubes included at least 2.0" above the uppermost elevation of the welds and 1.0" below the lowest elevation of the J-groove welds. This coverage is illustrated in Figure 4-2.

At eight penetration locations it was not possible to achieve 1.0" of TOFD coverage on the penetration tube OD surface below the lowest point of the weld. Supplementary eddy current examinations were performed on the tube OD surface at these eight locations to achieve the required 1.0" of coverage below the welds as described in Section 4.4.

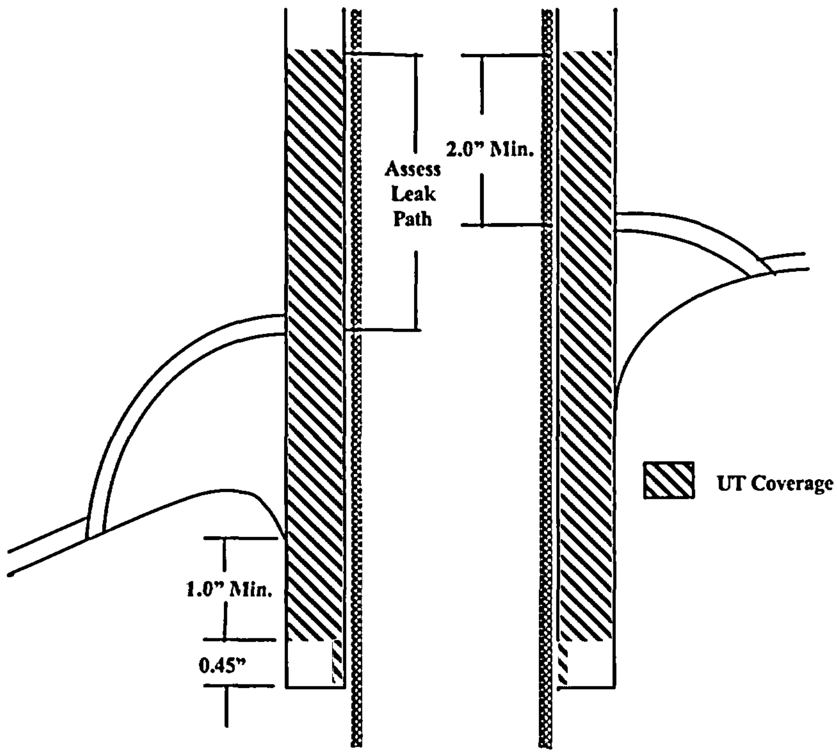


Figure 4-2: UT Coverage in Accordance With Section IV.C (5) (b) (i) of the Revised NRC Order

4.3 Eddy Current Coverage in Accordance With Section IV.C (5) (b) (i) of the Revised NRC Order

Gapscanner eddy current examinations were conducted on the remaining seventeen reactor vessel head penetration where the sizes of the gaps between the OD of the thermal sleeves and the ID of the penetration tubes varied around the circumference and the Trinity probes would not pass freely in the annulus. Eddy current blade probes with dual pancake eddy current coils were used to examine the tube ID surfaces. The thickness of the eddy current probes, when fully compressed, allows access into gaps on the order of 0.085" as compared to 0.095" for the Trinity probes.

Eddy current examinations were also conducted on the J-groove weld surfaces to a distance of 0.25" past the welds and on the OD surfaces of the penetration tubes using the Grooveman end effector.

Coverage provided by the eddy current examination program is illustrated in Figure 4-3.

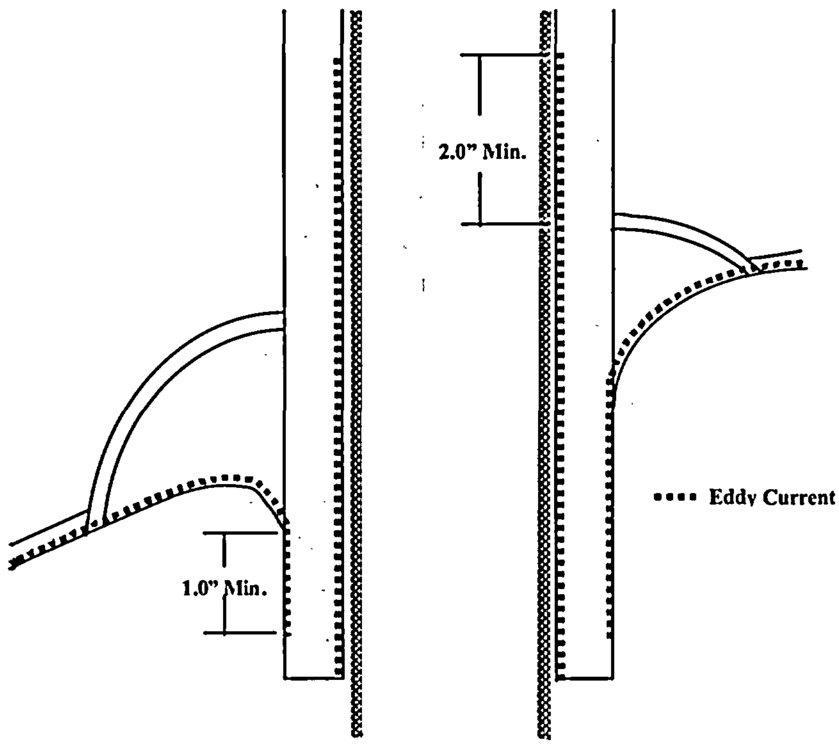


Figure 4-3: Wetted Surface Examination Coverage in Accordance With Section IV.C (5) (b) (ii) of the Revised NRC Order

4.4 Combination Ultrasonic and Eddy Current Coverage in Accordance With Section IV.C (5) (b) (iii) of the Revised NRC Order

At eight penetration locations it was not possible to achieve 1.0" of TOFD coverage on the penetration tube OD surface below the lowest point of the weld due to the combination of probe design and penetration geometry. Supplementary eddy current examinations were performed on the tube OD surface at these eight locations to achieve the required 1.0" of coverage below the welds.

For these locations, complementary eddy current examinations were performed on the OD penetration tube surfaces using the Grooveman end effector. These examinations were performed from the elevation where toe of the J-groove weld at its lowest elevation intersects the penetration tube to the bottom of the tube. Since the TOFD UT coverage below the weld at these eight locations varied from 0.6" to 0.96" below the weld, sufficient overlap was accomplished when the upper elevation of the scan was started at the point where weld intersects the tube.

Coverage provided by the combined ultrasonic and eddy current examination program is illustrated in Figure 4-4.

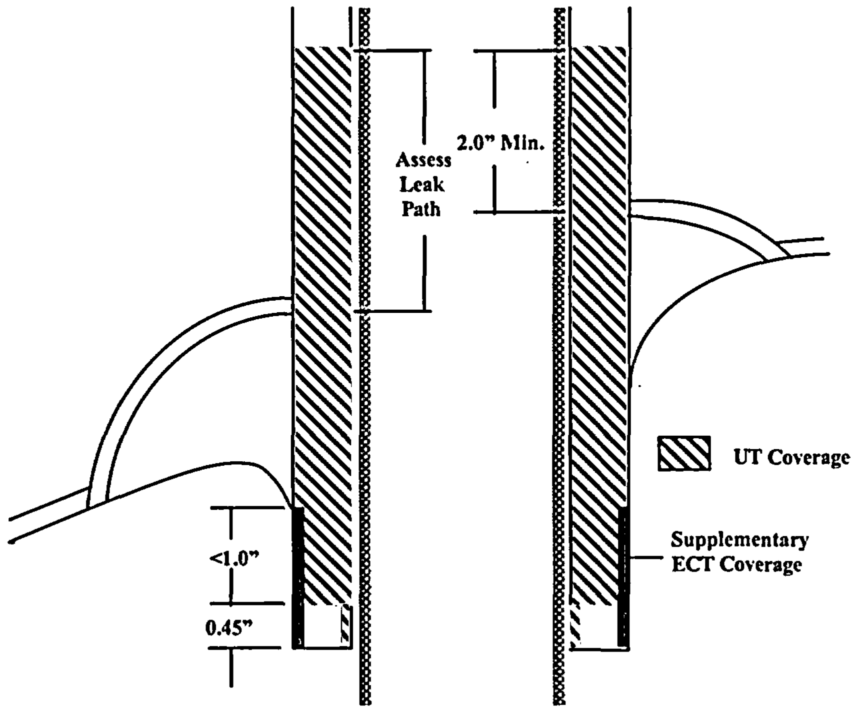


Figure 4-4: Combination UT and ECT Examination Coverage in Accordance With Section IV.C (5) (b) (iii) of the Revised NRC Order

5.0 DISCUSSION OF RESULTS

Penetration tube ultrasonic examination data were analyzed in accordance with WDI-UT-013, Rev. 5 with FCNs 01 and 02 – "CRDM/ICI UT Analysis Guidelines". Eddy current data were analyzed in accordance with WDI-ET-004, Rev. 5 with FCNs 01 and 02 – "IntraSpect Eddy Current Analysis Guidelines Inspection of Reactor Vessel Head Penetrations". Data from the Fall 2002 Robinson reactor vessel head penetration examinations were loaded on the analysis workstations to allow comparison of the current results with history. The disposition process for ID indications is summarized in the logic chart in Figure 5-1 and the process for OD indications is summarized in the logic chart in Figure 5-2.

Data sheets and printouts of the results of each examination performed on each penetration are found in Volume 2.

Eddy current results from tube inside diameter surface examinations identified twenty-four penetration tubes with indications characteristic of craze cracking. This phenomenon was found typically at the 180 degree location and below the weld. The craze cracking was not detectable with the TOFD ultrasonic probes, indicating the depths of this condition is significantly less than 0.040", the TOFD detection limit. As such, they are not considered to have any impact on the integrity of the reactor vessel head penetration tubes. All were confirmed by review of the historical data from the Fall 2002 reactor vessel head penetration examination and there was no increase in size.

Results from the TOFD ultrasonic and eddy current examinations of the sixty-nine reactor vessel head penetrations identified no indications characteristic of PWSCC.

Figure 5-1 - Penetration Tube ID Flaw Evaluation

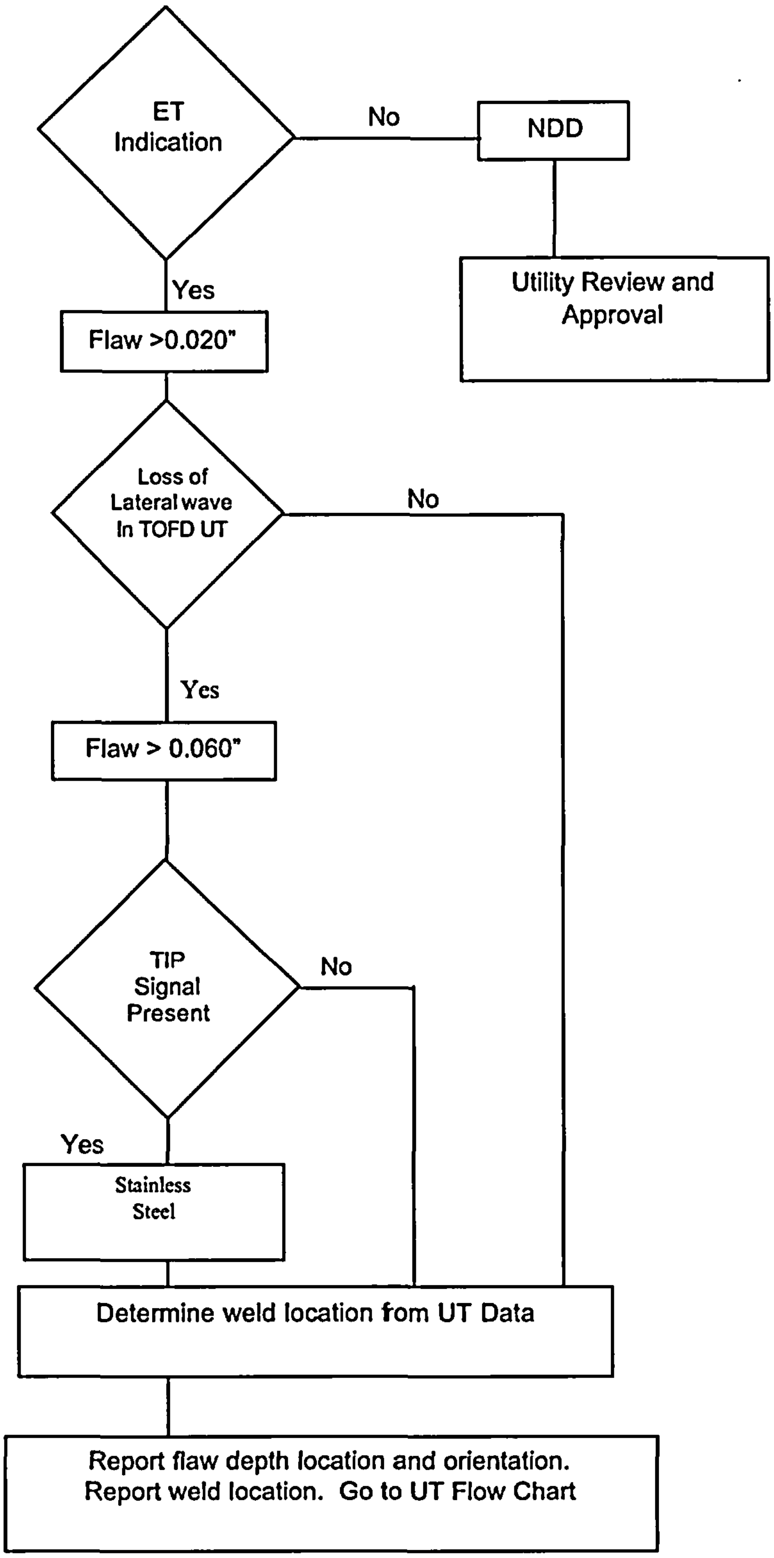
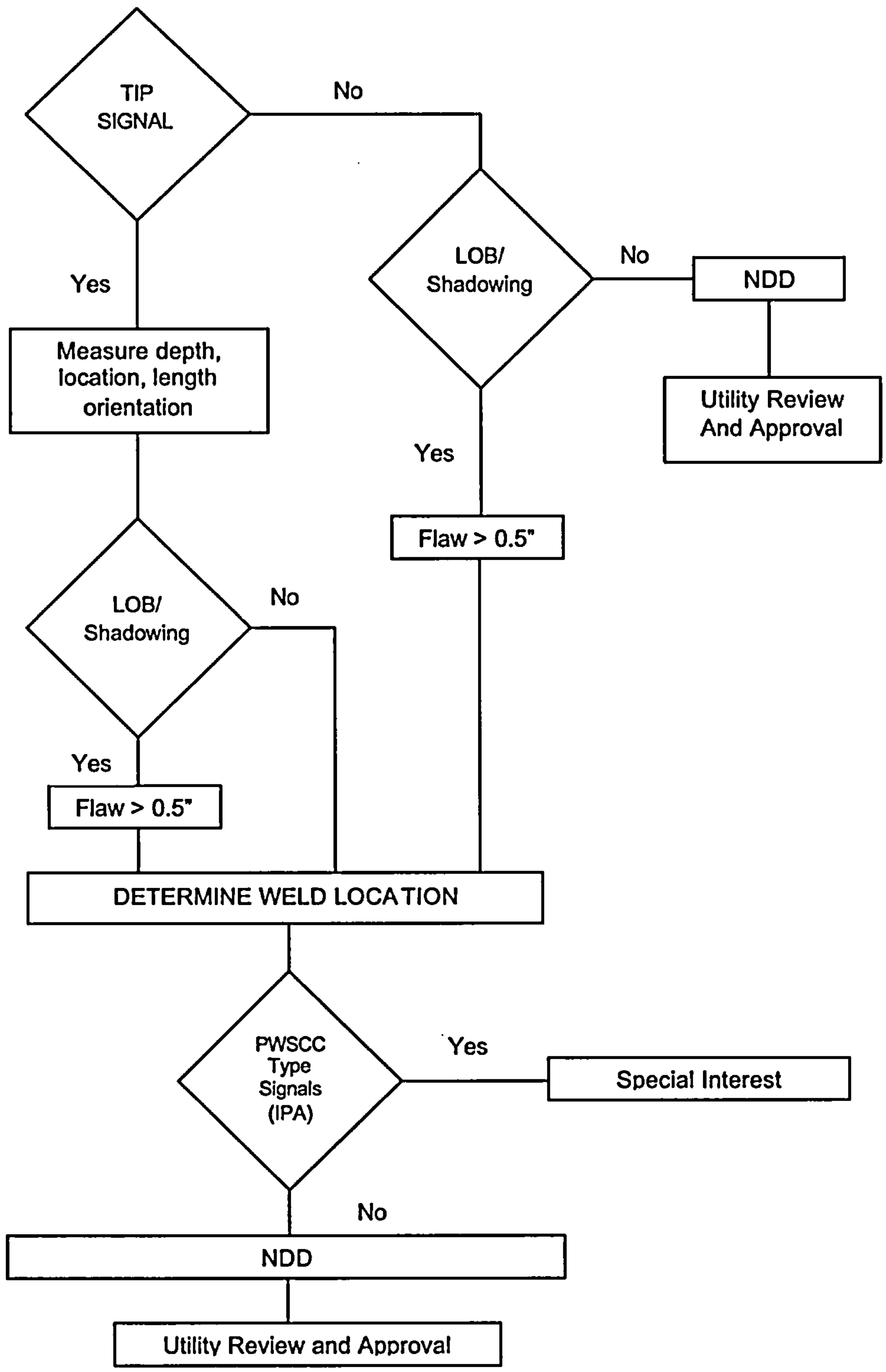


Figure 5-2 - Penetration Tube OD Flaw Evaluation



6.0 REFERENCES

[1] EPRI/MRP89 Technical Report, "Materials Reliability Program: Demonstrations of Vendor Equipment and Procedures for the Inspection of Control Rod Drive Mechanism Head Penetrations (MRP-89)", EPRI, Palo Alto, CA: July, 2003.

[2] USNRC Letter EA-03-009, "Issuance of First Revised NRC Order (EA-03-009) Establishing Interim Inspection Requirements for Reactor Vessel Heads at Pressurized Water Reactors", February 20, 2004.

Westinghouse

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Westinghouse S.O.: 25084
Customer P.O.: 3382
Task Work Auth. #: 37
Our ref: PGN-04-33

April 21, 2004

PROGRESS ENERGY
H. B. ROBINSON
RVH Penetration Stress Distributions

Dear Mr. Caba:

Attached are curves (LTR-PAFM-04-32) for noted penetrations showing stress distributions including the distance from the bottom of the J groove weld to where the hoop stress drops below 20 ksi. If you have any questions concerning these curves please call either Chris Ng on 724-722-6030 or Warren Bamford on 724-722-6049.

Sincerely,

WESTINGHOUSE ELECTRIC COMPANY LLC

Dwain W. Alexander
Customer Projects Manager

Attachment

cc: Pete Harden — Westinghouse Charlotte
Chris Church — Robinson
J. Zook — Westinghouse

Westinghouse

To: Dwain Alexander
cc: Seth Swamy

From:
Ext: 724-722-6030
Fax: 724-722-5597

Date: April 20, 2004

Your ref:
Our ref: LTR-PAFM-04-32

Attachment to: PGN-04-33 (10 Pages)

Subject: **Hoop Stress Distribution Curves and 20 ksi Inspection Zone for H. B. Robinson**

The hoop stress distribution below the J-weld Curves have been generated for the H. B. Robinson head penetration nozzles. The distance from the bottom of the weld to where the hoop stress drops below 20 ksi is also shown in each curve. Please transmit the attached information on pages 2 to 10 to CPL.

Author: ______________________

C. K. Ng[1], Piping Analysis & Fracture Mechanics

Verifier: ______________________

Santit Jirawongkraisorn[1], Piping Analysis & Fracture Mechanics

[1] Official Record Electronically Approved in EDMS 2000

A BNFL Group company

Figure 6-1

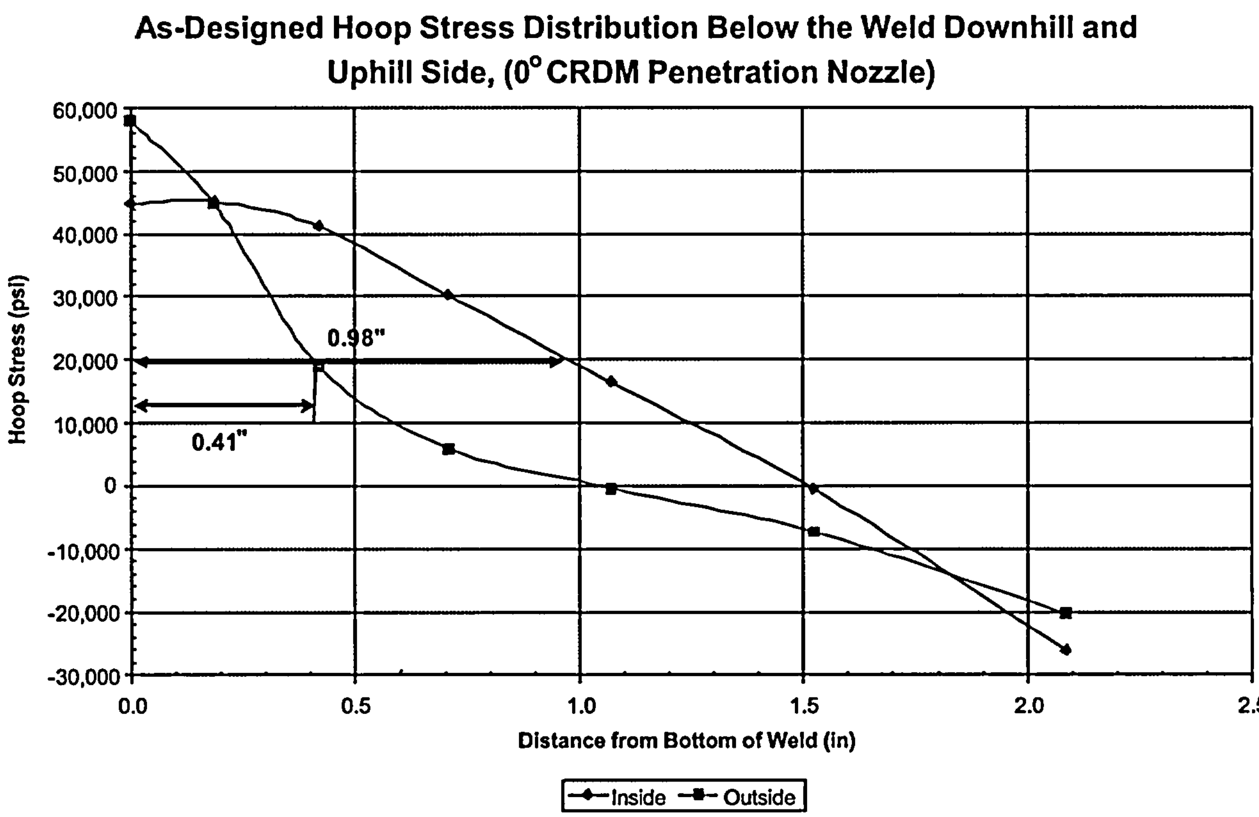
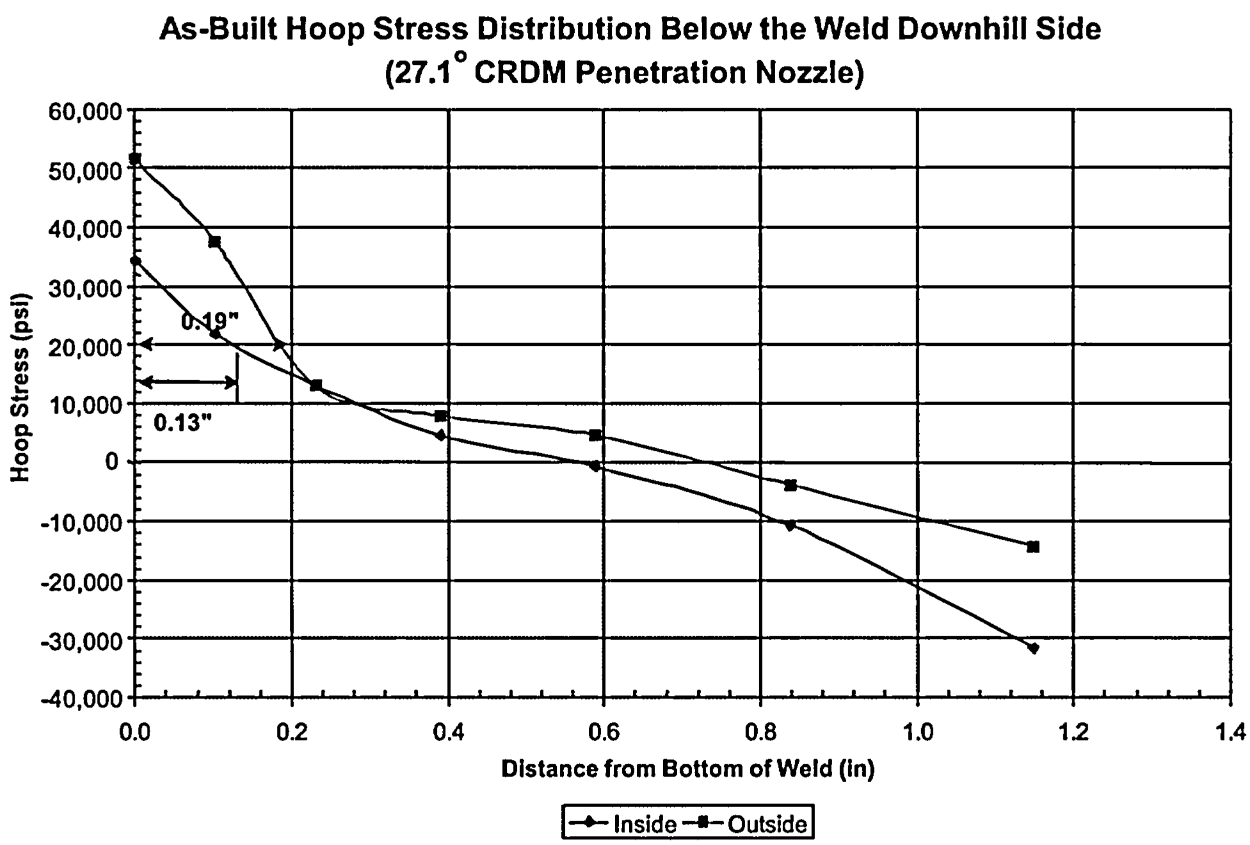

As-Designed Hoop Stress Distribution Below the Weld Downhill and Uphill Side, (0° CRDM Penetration Nozzle)
Hoop Stress (psi)
60,000
50,000
40,000
30,000
20,000
10,000
0
-10,000
-20,000
-30,000
0.0
0.5
1.0
1.5
2.0
2.5
Distance from Bottom of Weld (in)
0.98"
0.41"
Inside
Outside

Figure 6-2



As-Built Hoop Stress Distribution Below the Weld Downhill Side
(27.1° CRDM Penetration Nozzle)
60,000
50,000
40,000
30,000
20,000
10,000
0
-10,000
-20,000
-30,000
-40,000
Hoop Stress (psi)
0.19"
0.13"
0.0
0.2
0.4
0.6
0.8
1.0
1.2
1.4
Distance from Bottom of Weld (in)
Inside
Outside

Figure 6-3

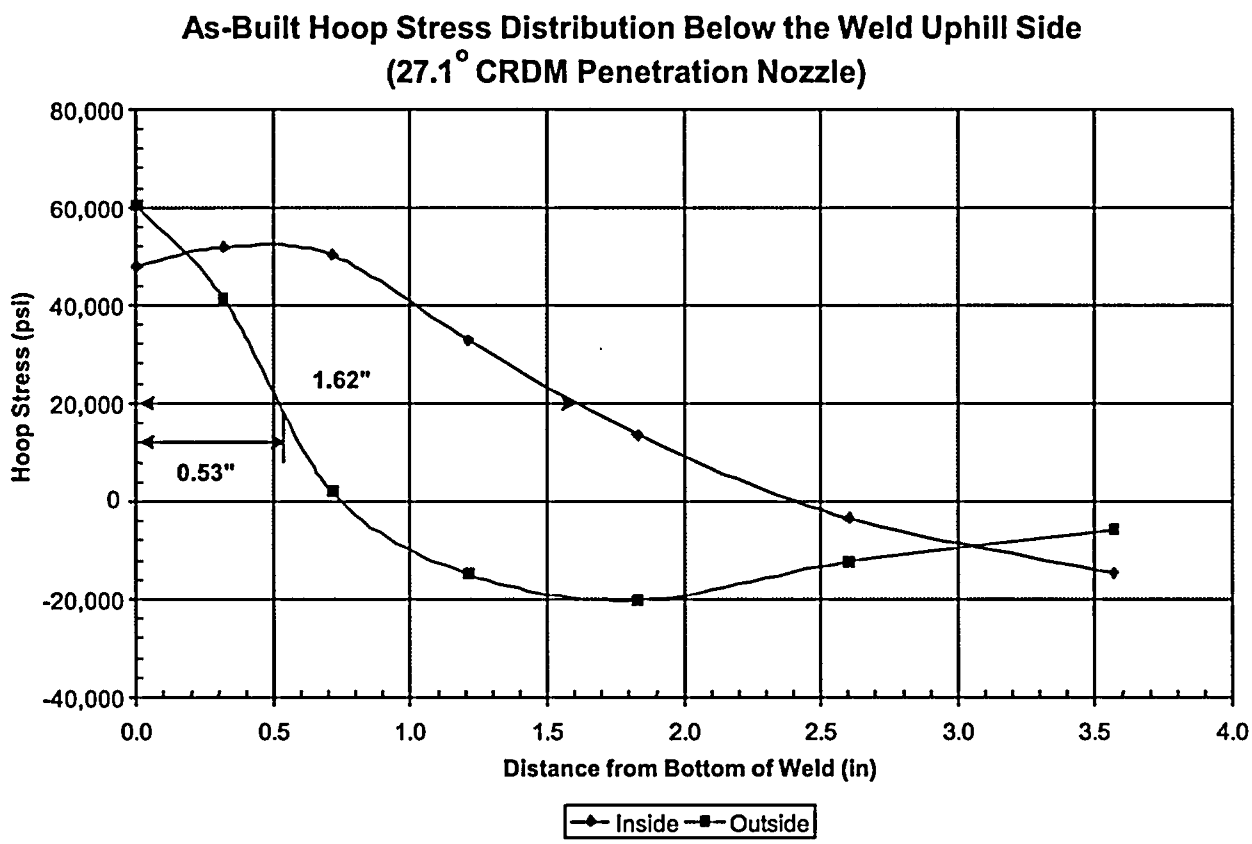

As-Built Hoop Stress Distribution Below the Weld Uphill Side
(27.1° CRDM Penetration Nozzle)
80,000
60,000
40,000
20,000
0
-20,000
-40,000
Hoop Stress (psi)
1.62"
0.53"
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
Distance from Bottom of Weld (in)
Inside
Outside

Figure 6-4

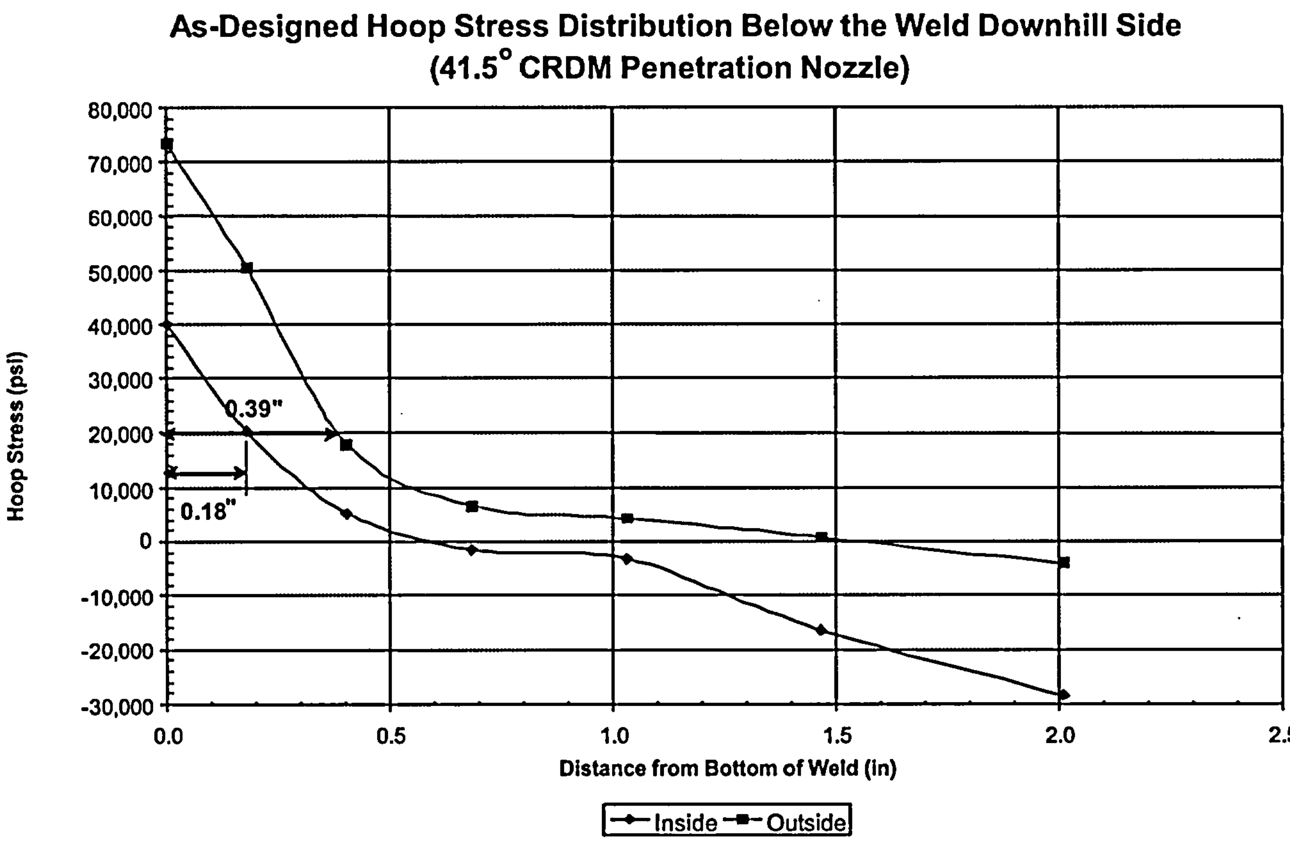

As-Designed Hoop Stress Distribution Below the Weld Downhill Side
(41.5° CRDM Penetration Nozzle)
80,000
70,000
60,000
50,000
40,000
30,000
20,000
10,000
0
-10,000
-20,000
-30,000
Hoop Stress (psi)
0.39"
0.18"
0.0
0.5
1.0
1.5
2.0
2.5
Distance from Bottom of Weld (in)
Inside
Outside

Figure 6-5

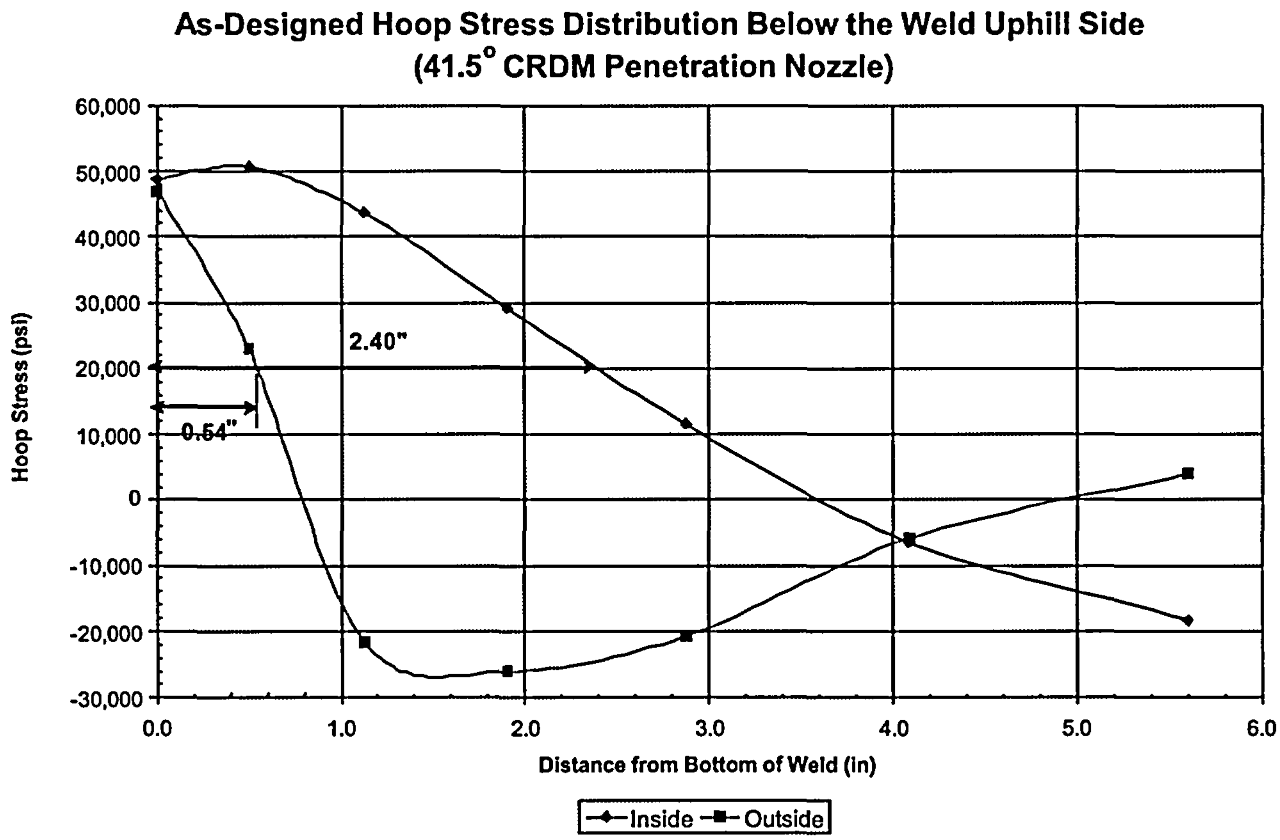

As-Designed Hoop Stress Distribution Below the Weld Uphill Side
(41.5° CRDM Penetration Nozzle)
60,000
50,000
40,000
30,000
20,000
10,000
0
-10,000
-20,000
-30,000
Hoop Stress (psi)
2.40"
0.54"
0.0
1.0
2.0
3.0
4.0
5.0
6.0
Distance from Bottom of Weld (in)
Inside
Outside

Figure 6-6

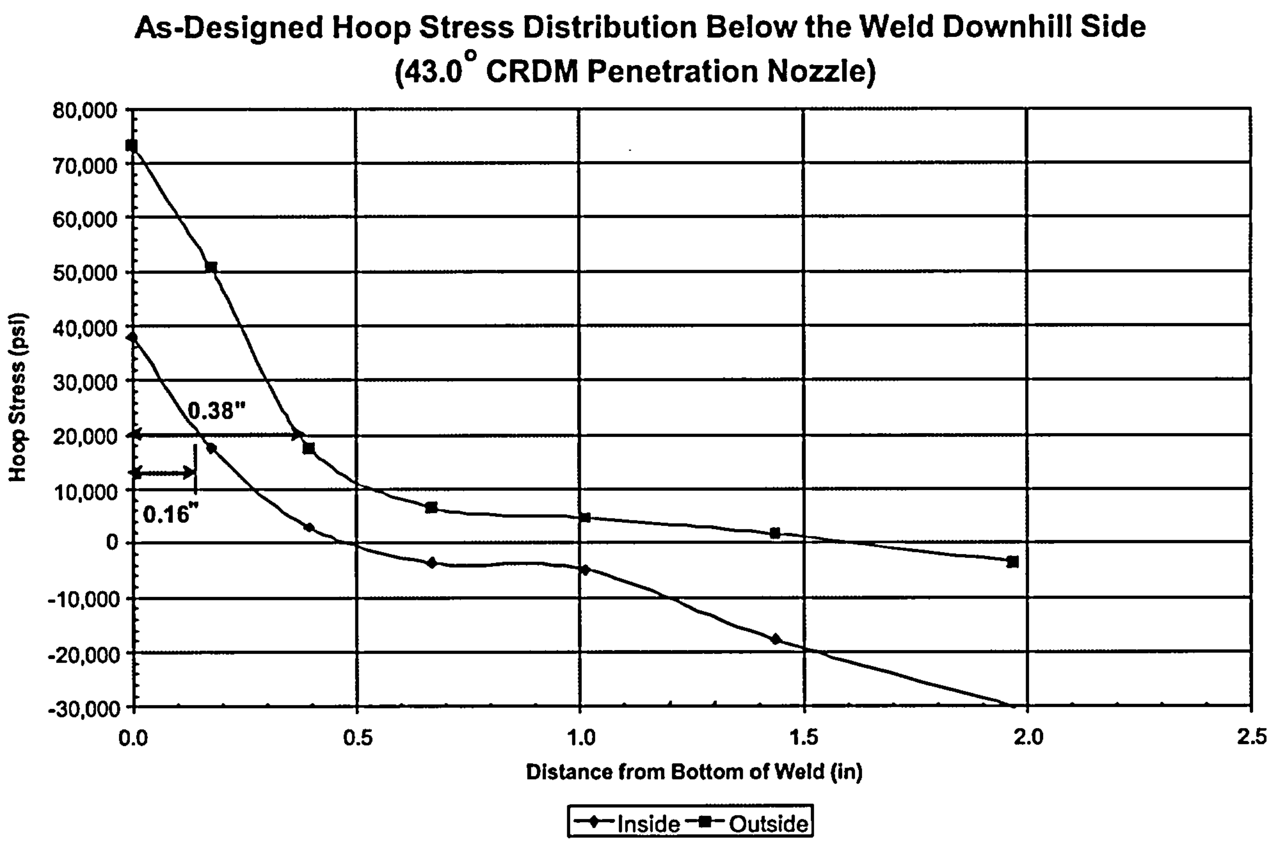

As-Designed Hoop Stress Distribution Below the Weld Downhill Side
(43.0° CRDM Penetration Nozzle)
80,000
70,000
60,000
50,000
40,000
30,000
20,000
10,000
0
-10,000
-20,000
-30,000
Hoop Stress (psi)
0.38"
0.16"
0.0
0.5
1.0
1.5
2.0
2.5
Distance from Bottom of Weld (in)
Inside
Outside

Figure 6-7

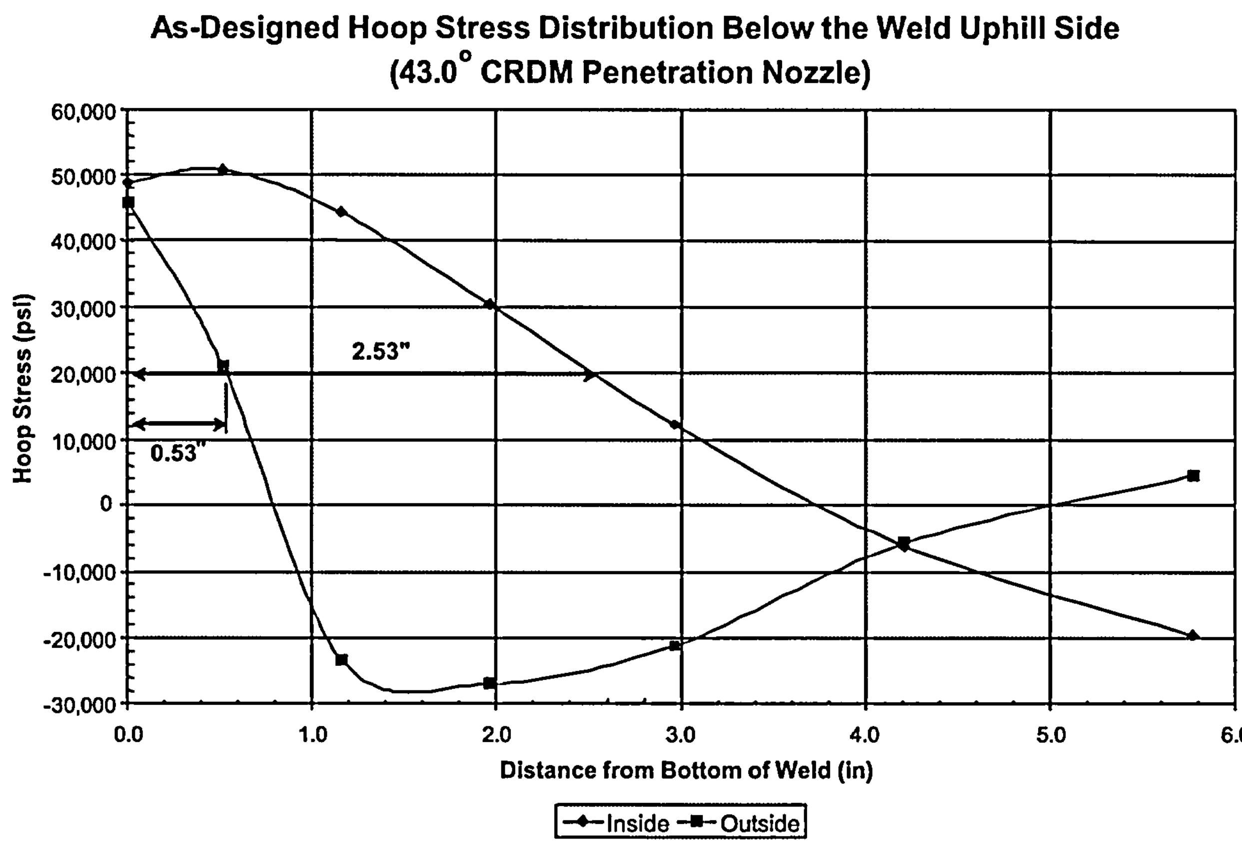

As-Designed Hoop Stress Distribution Below the Weld Uphill Side
(43.0° CRDM Penetration Nozzle)
60,000
50,000
40,000
30,000
20,000
10,000
0
-10,000
-20,000
-30,000
Hoop Stress (psi)
2.53"
0.53"
0.0
1.0
2.0
3.0
4.0
5.0
6.0
Distance from Bottom of Weld (in)
Inside
Outside

Figure 6-8

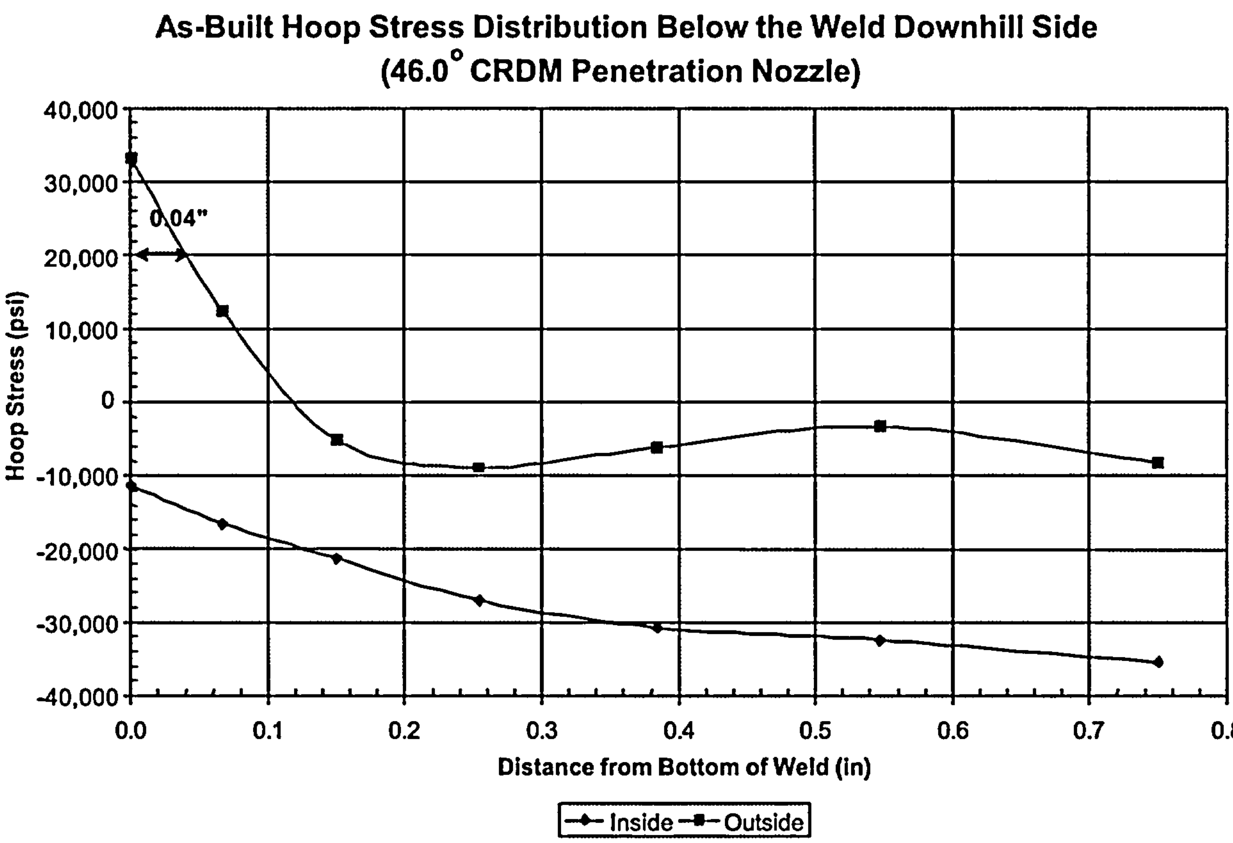
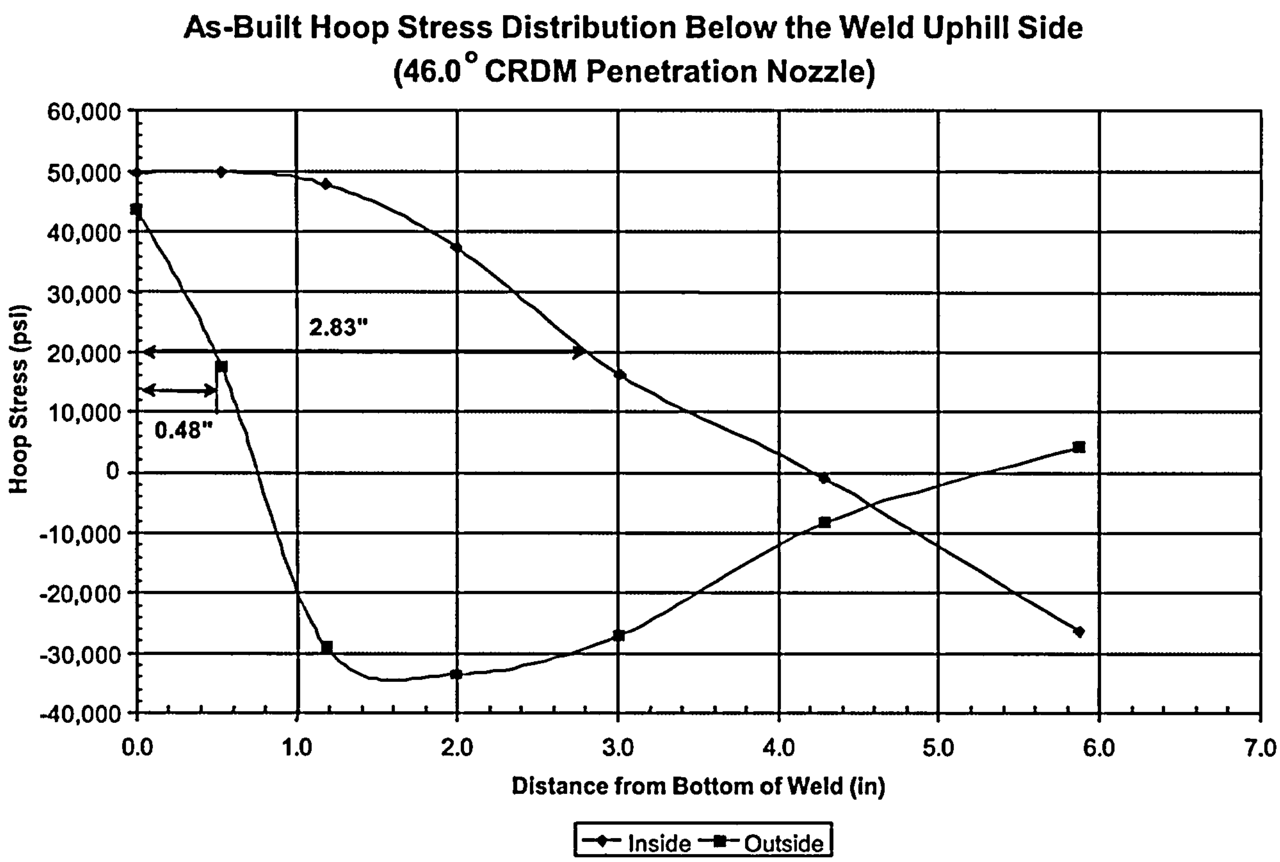

As-Built Hoop Stress Distribution Below the Weld Downhill Side
(46.0° CRDM Penetration Nozzle)
40,000
30,000
20,000
10,000
0
-10,000
-20,000
-30,000
-40,000
Hoop Stress (psi)
0.04"
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
Distance from Bottom of Weld (in)
Inside
Outside

Figure 6-9


As-Built Hoop Stress Distribution Below the Weld Uphill Side
(46.0° CRDM Penetration Nozzle)
60,000
50,000
40,000
30,000
20,000
10,000
0
-10,000
-20,000
-30,000
-40,000
Hoop Stress (psi)
2.83"
0.48"
0.0
1.0
2.0
3.0
4.0
5.0
6.0
7.0
Distance from Bottom of Weld (in)
Inside
Outside

Appendix B: H.B. Robinson Unit 2 RVHP Examination Coverage Summary

	UT Coverage In Accordance With Section IV.C (5) (b) (i) of the Revised NRC Order 44 of 69 Penetrations		ECT Coverage In Accordance With Section IV.C (5) (b) (ii) of the Revised NRC Order 17 of 69 Penetrations		Combined UT and ECT Coverage In Accordance With Section IV.C (5) (b) (iii) of the Revised NRC Order 8 of 69 Penetrations	
Penetration #	Open Housing Scanner	Trinity Probes	Tube ID ECT	J-Groove Weld and Tube OD ECT	Trinity Probes	Tube OD ECT
1		X				
2	X					
3	X					
4	X					
5	X					
6		X				
7		X				
8		X				
9		X				
10		X				
11	X					
12		X				
13		X				
14		X				
15			X	X		
16		X				
17		X				
18		X				
19		X				
20		X				
21		X				
22		X				
23			X	X		
24			X	X		

	UT Coverage In Accordance With Section IV.C (5) (b) (i) of the Revised NRC Order 44 of 69 Penetrations		ECT Coverage In Accordance With Section IV.C (5) (b) (ii) of the Revised NRC Order 17 of 69 Penetrations		Combined UT and ECT Coverage In Accordance With Section IV.C (5) (b) (iii) of the Revised NRC Order 8 of 69 Penetrations	
Penetration #	Open Housing Scanner	Trinity Probes	Tube ID ECT	J-Groove Weld and Tube OD ECT	Trinity Probes	Tube OD ECT
25		X				
26			X	X		
27			X	X		
28		X				
29		X				
30		X*	X	X		
31		X				
32			X	X		
33			X	X		
34		X				
35			X	X		
36		X				
37			X	X		
38					X	X
39			X	X		
40			X	X		
41		X				
42		X				
43					X	X
44					X	X
45		X				
46	X					
47	X					
48	X					
49	X					
50	X					
51	X					

	UT Coverage In Accordance With Section IV.C (5) (b) (i) of the Revised NRC Order 44 of 69 Penetrations		ECT Coverage In Accordance With Section IV.C (5) (b) (ii) of the Revised NRC Order 17 of 69 Penetrations		Combined UT and ECT Coverage In Accordance With Section IV.C (5) (b) (iii) of the Revised NRC Order 8 of 69 Penetrations	
Penetration #	Open Housing Scanner	Trinity Probes	Tube ID ECT	J-Groove Weld and Tube OD ECT	Trinity Probes	Tube OD ECT
52	X					
53	X					
54	X					
55	X					
56	X					
57	X					
58		X				
59		X				
60					X	X
61					X	X
62					X	X
63			X	X		
64			X	X		
65			X	X		
66					X	X
67					X	X
68			X	X		
69			X	X		
* Partial Scan						